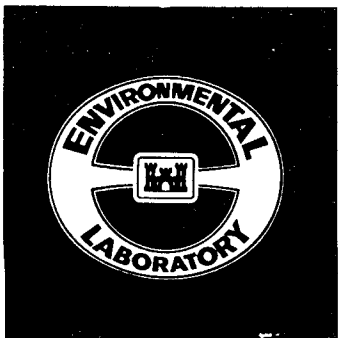




**US Army Corps
of Engineers**



ENVIRONMENTAL IMPACT RESEARCH PROGRAM

TECHNICAL REPORT EL-86-25

Chapter 1. INTRODUCTION

US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Martin also served as principal investigator for the work unit. Numerous biologists within the Corps and from other agencies assisted with the work unit and prepared sections of the manual. The following individuals are especially acknowledged for their contributions: Dr. Wilma A. Mitchell, WES; Mr. James W. Teaford, WES; Mr. Larry E. Marcy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Tex.; Mr. Ted B. Doerr, Range Science Department, Colorado State University, Fort Collins, Colo.; and Mr. E. Paul Peloquin, Construction-Operations Division, US Army Engineer Division, North Pacific, Portland, Oreg.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division (PGAD). Most of the drawings used in manual reports were prepared by Messrs. John R. Harris and David R. (Randy) Kleinman, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

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CHAPTER 1. INTRODUCTION

US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

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This report serves as the introductory chapter to the US Army Corps of Engineers Wildlife Resources Management Manual. The manual is the major product of a work unit entitled "Management of Corps Lands for Wildlife Resource Improvement," sponsored by the Environmental Impact Research Program (EIRP) of the Office, Chief of Engineers, US Army. The work unit designation is EIRP 31631.

BACKGROUND

An important aspect of the multiobjective Civil Works mission of the US Army Corps of Engineers is the stewardship of lands entrusted to it by the public. These lands, approximately 11 million acres on approximately 460 projects nationwide, contain a wealth of natural resources subjected to a variety of activities. The wise use of these resources requires an integrated approach that applies principles and expertise from a variety of disciplines.

The management of game and nongame wildlife and their habitats on project lands is a major segment of the Corps natural resources management program, as indicated by the more than 3.5 million acres of land and water which are presently under some form of wildlife management at Corps projects throughout the country. The species and management practices range from the familiar to the unique, habitats range from coastal marshes to montane forests, and

settings range from the remote to the metropolitan. Corps wildlife biologists and natural resource specialists are, therefore, faced with many wildlife management opportunities that require a diversity of technical skills and information.

PURPOSE

The purpose of this manual is to provide wildlife management information to all Corps personnel involved in wildlife resource activities. The major emphasis is to provide guidance on biologically sound, technically reliable, and cost-effective wildlife management practices tailored to Civil Works project settings. Primary users should include District and Division biologists and resource managers responsible for the administration, planning, implementation, and operation of wildlife management activities. The information provided should be of value for various Corps functions, including the preparation of Environmental Assessments and Environmental Impact Statements, development of mitigation plans, preparation of General Design Memoranda and Master Plans, development of contract specifications, and the design and operation of wildlife management programs. Contents of the manual are also expected to be useful to military installations and many other agencies, organizations, and individuals outside the Corps of Engineers.

ORGANIZATION AND SCOPE

A manual format was chosen for presentation of material because of the diversity of topics addressed. The manual is arranged in the following chapters:

- Chapter 1. INTRODUCTION
- Chapter 2. MANAGEMENT CONCEPTS AND OBJECTIVES
- Chapter 3. PROJECT SETTINGS
- Chapter 4. WILDLIFE SPECIES ACCOUNTS
- Chapter 5. MANAGEMENT PRACTICES AND TECHNIQUES
- Chapter 6. CENSUS AND SAMPLING TECHNIQUES
- Chapter 7. PLANT MATERIALS
- Chapter 8. EQUIPMENT
- Chapter 9. GLOSSARY

Each chapter of the manual is organized into parts and sections, which are numbered accordingly. The section is the lowest topic level to which numbers are assigned. An example of format is shown below for Chapter 5.

Part 5.1 NESTING AND ROOSTING STRUCTURES

Section 5.1.1 SQUIRREL NEST BOXES

Section 5.1.2 WOOD DUCK NEST BOXES

Section 5.1.3 WATERFOWL NEST BASKETS

Section 5.1.4 GOOSE NESTING STRUCTURES

Part 5.2 FENCES AND CROSSINGS

Section 5.2.1 CONVENTIONAL WIRE FENCES

Section 5.2.2 SPECIAL WIRE FENCES

Section 5.2.3 IMPASSABLE WIRE FENCES

Section 5.2.4 WOODEN FENCES

In most cases each section of a chapter is a distinct product and is published as a separate Technical Report coded to the manual. Exceptions to this occur in Chapters 2 and 3 where chapter parts are prepared as individual reports. Each part or section is designed to stand by itself, but information within reports is cross-referenced to other chapters of the manual. For example, basic information on appropriate management strategies for the osprey is included in Chapter 4 -- Wildlife Species Accounts, Part 4.3 -- Raptors, Section 4.3.1 -- Osprey (*Pandion haliaetus*), but detailed guidelines on the development of artificial nesting habitat are provided in Chapter 5 -- Management Practices and Techniques, Part 5.1 -- Nesting and Roosting Structures, Section 5.1.6 -- Osprey Nest Platforms.

The general scope of Chapters 2 through 8 is summarized below. Chapter parts are listed, and the types of subjects covered for manual reports are described.

MANAGEMENT CONCEPTS AND OBJECTIVES

The purpose of Chapter 2 is to address basic ecological and management concepts and put them into context with Civil Works project settings. The importance of establishing goals for designated management areas and designing programs to support the accomplishment of these goals are emphasized. Issues include the development of project and regional goals, inclusion of wildlife management as part of the multipurpose project concept, and selection of

management strategies compatible with project operation and maintenance requirements. The selection and implementation of management instruments such as contracts, leases, licenses, and cooperative agreements are also discussed.

Biological and ecological principles governing the management of habitat and associated animal populations are discussed under appropriate topic headings. The dynamics of biological communities and ecological succession are discussed in regard to Corps projects. A variety of management strategies suitable for project lands are presented; these include the management unit approach, management for target/featured species, and management for species richness/community diversity. The need for considering such factors as habitat diversity, succession patterns, carrying capacity, interspersion, limiting factors, and adjacent land uses when designing a management program are discussed.

PROJECT SETTINGS

Major categories of Civil Works projects and associated features with wildlife and habitat development potential are described in Chapter 3. The main objective is to provide the Corps biologist or natural resource manager with a basic understanding of the engineering characteristics and physical features associated with a project to facilitate selection of wildlife management practices compatible with project design and operation.

US Army Corps of Engineer projects may be defined according to a variety of shared qualities such as purpose, authority, cost, location, and physical characteristics. Although the Corps literature often groups projects according to purpose or authority, these classification systems are somewhat ambiguous; for example, "local protection" or "flood damage reduction" may refer to channels, floodwalls, levees, reservoirs, floodways, or clearing and snagging. The following project categories were chosen for presentation in this chapter based on a combination of physical features, operational procedures, hydraulics, and use patterns that affect wildlife management.

- 3.1 STORAGE RESERVOIRS
- 3.2 RUN-OF-RIVER RESERVOIRS
- 3.3 DRY RESERVOIRS
- 3.4 WATERWAY PROJECTS
- 3.5 COASTAL (DEEP-DRAFT) WATERWAYS

3.6 BEACH EROSION CONTROL PROJECTS

3.7 OTHER CORPS PROJECTS AND ACTIVITIES

Topics covered under each project category include a general description and definition, project purposes, project authorization, design and physical characteristics, operation and maintenance, and features generally associated with the project. Design and physical characteristics include a description of a prototype or typical design and most frequently encountered variations. Environmental considerations and design alternatives are addressed where appropriate. Typical and unusual or extreme conditions for operation and maintenance are discussed. Project features and zones with wildlife management potential are identified, and constraints imposed on management activities by operation, maintenance, or structural safety requirements are discussed.

WILDLIFE SPECIES ACCOUNTS

In order to conduct proper planning or management for a species, it is essential that the biologist or resource manager have access to the most up-to-date information on the biology, ecological requirements, and management technology for that species. This information is generally available, especially for game animals, but is often scattered throughout the technical literature and may be difficult to obtain and analyze within a reasonable time period. Species Accounts provided in Chapter 4 are an effort to bring together under one cover the pertinent information required to manage a resource for a particular target species.

Organization

Accounts are presented for a variety of game and nongame species. In some cases subspecies may be treated as separate accounts where information on the species as a whole is too extensive for one report. Also, certain nongame species accounts may combine closely related species with similar habitat requirements. Accounts are organized within the following major categories:

4.1 GAME BIRDS

4.2 WATERFOWL

4.3 RAPTORS

4.4 SHORE AND WATER BIRDS

4.5 SONGBIRDS

4.6 BIG GAME MAMMALS

4.7 SMALL GAME MAMMALS AND FURBEARERS

4.8 NONGAME MAMMALS

4.9 REPTILES AND AMPHIBIANS

The arrangement of species accounts within each category reflects the sequence in which accounts were completed rather than taxonomic order. This arrangement was necessary for timely publication of reports.

Contents

Each account contains at least the following major topics: status, characters and measurements, population attributes, and habitat requirements. Accounts begin with an introduction that identifies the species and describes its current distribution. A range map, showing the geographic distribution of subspecies, is provided. Where appropriate, subspecies are listed in the caption and coded to the map. Although taxonomic categories below the species level are not generally used for management purposes, the reader may need to be aware of the subspecies referred to in the literature.

Information presented under major topic headings is described below. Subtopics may vary from species to species depending upon the availability of appropriate material. Measurements are given in both metric (SI, Scientific International) and non-SI units except for the topic Characters and Measurements, where only non-SI units are used.

Status. Basic information on the ecological and economic importance of a species is presented. Federal and State laws and regulations applicable to a species are discussed, if appropriate. Detailed information is provided on the status of a species, or populations of the species, designated as Threatened or Endangered by Federal or State agencies.

Characters and measurements. Diagnostic features important for field identification are described, and appropriate details on seasonal and geographic variation are presented. Comparisons are made with similar species if necessary. Criteria for distinguishing sexes and age classes are presented. The most acceptable sexing and aging techniques are described, and their advantages and limitations for field application are discussed.

Population attributes. An understanding of the population characteristics of a species is essential for proper management. This section provides detailed information on population densities, home range and movements,

breeding biology, and mortality. Density estimates throughout the range of a species are given and, where possible, variations in density are correlated with geographic location and differences in habitat quality and quantity. Other measurements of abundance are presented where density values are not available. Subtopics such as home range, cruising radius, territory, seasonal movements, migration and dispersal, and recruitment are included under home range and movements. Breeding biology contains facts on breeding season, breeding age and longevity, clutch or litter size, nest and hatching success, and sex and age ratios. Major mortality factors such as environmental stress, predation, and disease are discussed in relation to population impacts.

Habitat requirements. This section contains information the manager should know regarding the basic needs of a species within a given habitat. The habitat components required to support a population of the species are addressed first. This subject includes a description of the kinds, amounts, percentages, and combination of cover types required. Food habits information includes nutritional requirements, preferred and emergency foods, seasonal differences, regional variation, and differences in dietary requirements by age classes. Food habits information is summarized and presented in tabular form as much as possible. Water requirements and sources are described. Cover is broken down into specific requirements such as foraging, reproductive, and escape cover. Other habitat requirements of the species are discussed as appropriate.

Management. The necessary setting required for management of the species is first described. Recommendations are made for components and features that should be present at a site in order to conduct appropriate management practices. Details on minimum and optimum amounts and interspersions of components are included. Major objectives for management of the species and constraints on these objectives are discussed. Management practices and techniques appropriate to managing populations within the management unit are grouped into subtopics such as nesting structures, agricultural practices, plantings, cover and edge development, forest management, and protection. The reader is referred to the appropriate section in Chapter 5 for details on the design and application of specific management practices.

Census and sampling. A general description of the most appropriate census and sampling techniques for a species and its habitat components is provided in this section. Methods are recommended according to sex, age, and

season. Detailed information on design specifications, personnel requirements, costs, and data analysis for selected techniques is provided in Chapter 6, Census and Sampling Techniques.

MANAGEMENT PRACTICES AND TECHNIQUES

Numerous techniques have been developed that are suitable for wildlife and habitat management at US Army Corps of Engineers projects. The purpose of Chapter 5 is to provide detailed information on technically reliable and efficient practices that may be considered as part of a management program. Information presented should have wide application to both Planning and Construction-Operations functions within the Corps. Where appropriate, techniques are associated with project types and features described in Chapter 3, Project Settings.

The selection of management techniques for a specific project should be based on the project setting, operational constraints of the project, land use patterns, habitat requirements for target species and communities, unit and operational costs, and personnel requirements for construction and maintenance. A management program will generally require the application of several techniques within designated units of land and water. Care should be taken to consider juxtaposition of habitat components, project features, and suitability of techniques when designing a management plan.

Organization

Each technique described is developed as a chapter section that is arranged under a major heading with other related techniques. Information is cross-referenced where overlap occurs among headings and techniques. Chapter parts are organized as follows:

- 5.1 NESTING AND ROOSTING STRUCTURES
- 5.2 FENCES AND CROSSINGS
- 5.3 COVER AND EDGE DEVELOPMENT
- 5.4 WATER DEVELOPMENTS
- 5.5 WETLAND HABITAT MANAGEMENT
- 5.6 UPLAND HABITAT MANAGEMENT
- 5.7 HABITAT MANIPULATION
- 5.8 SPECIAL MANAGEMENT SITUATIONS
- 5.9 MISCELLANEOUS MANAGEMENT ACTIVITIES

Contents

Each technique contains information on the following topics: management objectives, wildlife value, design and construction, installation, placement, maintenance, personnel requirements and costs, evaluation and records, and cautions and limitations. A table of contents is provided at the beginning of each section, and referenced material is thoroughly cited. Measurements are given in non-SI units only unless the situation requires the display of both non-SI and metric units.

Each technique is introduced with a general discussion of its purpose and application. Benefits to wildlife, including target and nontarget species, are addressed, and regional application is discussed. Guidelines are provided for site selection and placement, including recommendations for spacing and interspersions of associated techniques.

Details are then presented for design and construction, including a thorough description of materials, design variations, labor, and costs. Step-by-step procedures for construction and installation are given where appropriate, and all construction and assembly details are complemented by schematic drawings and photographs. Personnel and cost requirements are provided for materials, construction, installation, and maintenance. The necessary inspection, maintenance, and records appropriate for each technique are described.

A discussion of cautions and limitations is presented for each technique. Critical requirements for construction, installation, location, and maintenance are stressed under this topic to ensure that implementation of the technique produces successful results. Safety requirements are also strongly emphasized.

Many of the techniques described have widespread application throughout the Corps, but some may have only regional utility. For example, site preparation techniques, methods for edge development, and songbird nest boxes are useful practices nationwide, whereas guzzlers and elevated quail roosts are generally appropriate only in arid to semiarid western regions. Regional variation is addressed as much as possible within each technique, but coverage of all differences is beyond the scope of the manual. Corps biologists and resource managers are encouraged to consult with area specialists from universities, State wildlife and conservation departments, and other Federal agencies when planning and implementing techniques for a particular species or project.

CENSUS AND SAMPLING TECHNIQUES

The proper selection and application of census and sampling techniques are important for obtaining appropriate baseline information and providing feedback on the success of wildlife management practices. The purpose of Chapter 6 is to present detailed information on techniques suitable for measuring habitat components and estimating wildlife populations on Corps lands. A variety of methods useful to both Corps planners and field biologists are described.

Each technique presented is included as a chapter section arranged under a major heading with other related techniques. In some cases a chapter part (e.g., Vegetation Sampling Techniques) is prepared as a separate report that provides an overview of techniques described in the attendant sections. Related techniques are developed in sequence as much as possible. Chapter parts are organized as follows:

- 6.1 HABITAT-BASED INFORMATION SYSTEMS
- 6.2 VEGETATION SAMPLING TECHNIQUES
- 6.3 BIRD SURVEY/CENSUS TECHNIQUES
- 6.4 MAMMAL SURVEY/CENSUS TECHNIQUES
- 6.5 MISCELLANEOUS TECHNIQUES

Each technique described contains information on the following topics: objectives, target species or communities, regional application and variation, cautions and limitations, sampling design and criteria, field application, material requirements, personnel and costs, data analysis and interpretation, and literature cited. Emphasis is placed on detailed step-by-step procedures for setting up techniques and applying them to project settings. Examples are provided for statistical analysis of data, and graphic illustrations and data forms are included to facilitate use of the techniques. Measurements are usually given in metric units, with non-SI units in parentheses, except where application of the technique requires that non-SI units take priority.

An attempt is made to provide information on a variety of techniques that have wide application to Corps project needs. However, inclusion of all suitable census and sampling techniques is beyond the scope of this manual. Regional variation in use of techniques is addressed as much as possible, but District and project biologists should consult area specialists and statisticians regarding site-specific information and handling of data.

PLANT MATERIALS

The proper selection, cultivation, and management of plant materials are important to habitat development and natural resource management programs at Corps projects. The purpose of Chapter 7 is to provide the necessary biological and management information on selected plant species recommended for wildlife habitat improvement on project lands. Reports are developed for a variety of native and introduced plants that represent a wide range of geographic regions and habitat types. Emphasis is placed on vegetation known to be valuable as food and/or cover for a variety of game and nongame wildlife species.

Organization

Individual sections of this chapter are arranged under 5 major categories. Categories were chosen for ease of use by the layman, and most do not represent taxonomic groupings. Chapter parts are as follows:

- 7.1 GRASSES
- 7.2 AGRICULTURAL GRAIN CROPS
- 7.3 LEGUMES
- 7.4 MISCELLANEOUS FORBS AND HERBACEOUS SPECIES
- 7.5 WOODY SPECIES

Most accounts are prepared for individual species, but closely related species with similar habitat requirements and management uses are occasionally treated in one account. An attempt is made to discuss as many important species as possible, but inclusion of all species useful to wildlife is beyond the scope of this manual. Therefore, it will be necessary for the District or project biologist to supplement the accounts with plant materials information available from the USDA Soil Conservation Service, USDA Forest Service, range and agricultural experiment stations, and other State and Federal offices.

Contents

Each plant species account consists of at least the following major topics: description, distribution, habitat requirements, wildlife value, establishment, maintenance, and cautions and limitations. Each account begins with an introduction that identifies the species by scientific and common names and provides general information on major uses and management potential. Contents of major topic headings are discussed below. These are generalized topics

that may vary from report to report depending on species characteristics and available information.

Description. The major features of each species are described and illustrated. Details are given on growth habit, root structure, leaf shape and arrangement, floral characteristics, fruits and seeds, and other diagnostic characters. Time of flowering and seed production are discussed. Measurements are given in both metric and English units to aid in plant identification and to facilitate management use of the information; only English units are used in remaining portions of the report. Descriptions should aid in recognition of plants in the field but are not intended as a substitute for taxonomic keys.

Distribution. The geographic range of each species is described and shown on a map. The region of greatest management application is shown where appropriate. The potential distribution of introduced species is also given, and the geographical limits of cultivated strains and varieties are discussed.

Habitat requirements. Habitat preferences and tolerances are presented for each species, and site conditions necessary for best growth, survival, and seed production are described. Specifics are given for soil and moisture requirements, tolerances to shade and exposure, and ability to withstand competition from other forms of vegetation.

Wildlife value. Food and cover benefits to game and nongame wildlife are described, and information on the nutritional value of plant parts is provided when available. Regional and seasonal variation in importance to major wildlife species is discussed, and results of pertinent food habits studies are summarized.

Establishment. This section provides management guidelines on site selection, site preparation, and planting methods. Suitable locations for development of either natural stands or food plots are discussed, and other habitat components that should be available at the site for wildlife populations are identified. The information on site preparation includes specifics on such topics as mechanical practices, fertilization, and other soil treatments needed prior to planting. Recommendations are given for the size, shape, and spacing of food plots to facilitate maximum use by wildlife. Propagule selection and planting methods are then described in detail. Guidelines are provided for seedbed preparation, planting time, planting depth, spacing, seeding methods and rates, and equipment use. Geographical variations in time

of planting and establishment techniques are discussed, and planting and seedling mixtures are recommended where appropriate.

Maintenance. Management practices required to ensure that plant materials continue to produce adequate food and cover after establishment are described. Depending on the species, maintenance activities described include mechanical treatments, burning, pruning, plot rotation, and protection of plots from grazing and competition. Details are provided on timing of maintenance events, and emphasis is placed on methods that require minimal costs and manpower.

Cautions and limitations. Potential management problems and limitations are discussed for each species. Subjects include insect pests and diseases, injuries and poisoning, tolerance to climatic extremes, control of unwanted dispersal, competition from other plant species, and impacts of grazing, browsing, and rodent damage. Limitations of the species in providing the needs of wildlife populations are also discussed.

EQUIPMENT

Proper selection and use of equipment are essential for a variety of wildlife management activities, especially where it is necessary to modify existing vegetation or restore disturbed sites to improve the habitat for selected target species. Types of equipment and attachments used for habitat development and manipulation are basically the same as those used in farming operations, range management, forestry, and other agricultural and horticultural practices. Chapter 8 provides general information on the major pieces of equipment useful for a variety of habitat management practices that may be appropriate on Corps lands.

Each piece of equipment described in this chapter is presented as a chapter section arranged in a major category with other related types of equipment. Occasionally several similar pieces of equipment are included in one section. Chapter parts are organized as follows:

- 8.1 TRACTORS AND DOZERS
- 8.2 SITE AND SEEDBED PREPARATION EQUIPMENT
- 8.3 SOIL AMENDMENT EQUIPMENT
- 8.4 DRILL AND BROADCAST SEEDERS
- 8.5 TRANSPLANTERS

- 8.6 HARVESTING EQUIPMENT
- 8.7 MISCELLANEOUS EQUIPMENT
- 8.8 TOOLS

Each equipment report contains information on the following major topics: description, operation, maintenance, limitations, and availability. A general description of standard and optimal components, modifications, capabilities, and dimensions is provided in text and tables, and typical features are illustrated. Operational characteristics described include power requirements, treatment rates and speeds, personnel requirements, and safety precautions. General maintenance guidelines are provided on storage, inspection, lubrication, routine repairs, and replacement of parts. Major limitations relative to power requirements, transportation, and terrain and soil characteristics are discussed for each piece of equipment.

The USDA Forest Service Equipment Development Centers in San Dimas, California, and Missoula, Montana; the Texas Agricultural Experiment Station; and numerous equipment companies assisted with this chapter by reviewing draft reports and providing specifications, drawings, and photographs. However, the inclusion of detailed design specifications and criteria for each type or brand of equipment was beyond the scope of this chapter. More detailed information may be obtained by contacting the appropriate Federal land management agency; State forestry, range, or agricultural experiment stations; or the equipment companies listed in each report.

WILDLIFE NEWSLETTER

A Corps newsletter entitled "Wildlife Resource Notes" has been published as a product of the work unit since June 1983. The newsletter was established primarily as a technology transfer forum whereby wildlife resource information pertinent to Civil Works Planning and Construction-Operations activities could be widely distributed to Corps District and Division offices as well as to other Federal and State agencies, universities, research institutes, corporations, and individuals. The newsletter is published quarterly or on an irregular basis as determined by the availability of appropriate information. The principal focus of newsletter articles is on Corps of Engineers programs, but reports on research and activities from other agencies and organizations are routinely included.

COMMENTS AND CREDITS

All parts of the manual have been reviewed by appropriate offices within the US Army Engineer Waterways Experiment Station (WES) and the Office, Chief of Engineers (OCE), and most reports were submitted for external review to other Corps offices and various State, Federal, and university personnel. Authors have been given full credit for their work, and other contributors and reviewers are acknowledged for their efforts. All literature, illustrations, and specifications cited or used in the manual have been credited to their original sources.

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